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THE DOW METAL PRODUCTS COMPANY
DIVISION OF THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

MANAGEMENT REPORT
PRODUCTION AND FABRICATION OF LA142 PELLETS
CONTRACT NO. DA-20-018-507-ORD-256
JUNE 3, 1963
FOR PERIOD FROM FEBRUARY 22, 1960 TO JUNE 3, 1963

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Prepared by:

J. F. Pashak
J. F. Pashak

Foreward

This report was prepared by The Dow Metal Products Co., a division of The Dow Chemical Company under modifications 1 through 5 to Contract No. DA-20-018-507-ORD-256 for Frankford Arsenal under the direction of MR. D. H. Kleppinger.

This report covers work conducted from February 22, 1960, to June, 1963.

ABSTRACT:

Pellets of LA142 alloy were produced in natural-gas and argon atmospheres. These pellets were extruded and rolled to sheet in the laboratory and the effect of processing variables on strength properties, corrosion resistance, and weldability determined. Pellets atomized in natural gas were also extruded and rolled to 2" thick plate on production equipment. This material was ballistically tested by Frankford Arsenal.

Atomizing atmosphere has little effect on the surface or fabrication characteristics of LA142 pellets. Properties of pellet products are unaffected by processing variables when fabrication temperatures do not exceed 400F. The strength properties of sheet and plate produced from pellets are somewhat better than those of material produced from ingot while corrosion resistance of the experimental material is far superior to that of the conventional product. Ballistic properties of plate produced from LA142 pellets are significantly better than those of any previously tested plate.

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Introduction:

Magnesium-lithium alloys are of interest in structural applications where minimum weight is of significant importance. This has resulted in programs designed to develop suitable alloys for use in space and armored vehicle applications.^{1,2,3,4.} A magnesium alloy containing approximately 13% lithium and 6% aluminum was found to exhibit desirable ballistic characteristics with weight saving over conventional armored vehicle plate. To obtain production experience in the casting, processing, and fabrication of this alloy, sufficient material was requested to assemble an experimental T113 vehicle (renamed M113).⁴ Problems were encountered in the casting and rolling of large LA136 slabs and it was found that plate of this composition was prone to cracking during welding. The composition was changed to LA142 (approximately 14% Li and 2% Al) and a test vehicle was assembled from this material.

Since many of the problems associated with the processing and fabrication of magnesium-lithium alloys have been due to casting defects (oxide, skins, etc.), it was felt that powder metallurgy techniques should be investigated as an alternate method for the production of LA142 ballistic plate. This report describes the production of LA142 pellets, the effects of processing variables on properties (laboratory scale), and the processing of LA142 pellets to 2" thick plate on production equipment.

Production of Pellets:

The LA142 pellets for this program were produced by jet atomizing since this process could be readily conducted in natural-gas or inert-gas atmospheres. In this method of atomizing, the vertical stream of metal is spread into a thin sheet and frozen into spherical particles by gas jets. The atomizing of magnesium alloys by the "disk" or "wheel" method has been described by Busk⁵ and this process has been used to

Produce large quantities of pellets for the production of commercial sections.

Metal was prepared for atomizing by melting pieces of LA142 plate in open, 125 pound crucibles, under a cover of NA# 8166 flux (38 LiCl-12LiF-50KCl). The molten metal was then poured into a head pot directly above the atomizing unit and held in the range of 1250-1300F prior to entering the chamber. Composition ranges obtained from several samples of starting material are shown below:

% AL	% Ca	% Cu	% Fe	% Li	% Mn	% Ni	% Pb	% Si	% Sn	% Zn
1.1-1.5	<.01	.001-.003	<.001	12.5-13.5	.05-.17	<.001	<.002	<.01	<.01	<.02

Production details for the various LA142 pellet runs are found in Table I with spectroscopic and chemical analyses of these materials presented in Table II.

A natural-gas atmosphere was used in the atomizing of the first three LA142 melts. The pellets produced were somewhat dull in color but otherwise not appreciably different in appearance than the more common magnesium alloy pellets. There was however, a larger proportion of fine pellets in the LA142 alloys than would normally be expected. An average analysis of six samples from these runs showed carbon and hydrogen contents to be 0.04% and 0.030% respectively.

Argon was used as the atomizing atmosphere for two, and natural-gas for one, of the last three LA142 melts prepared for laboratory evaluation. There were no significant differences in surface characteristics between the pellets atomized in natural gas and those atomized in argon. Since only minor differences were found in the fabrication characteristics or properties of materials produced from these pellets, it was concluded that an evaluation of atmosphere additives would not be necessary and that the atomizing of LA142 pellets for production processing should be carried out in an atmosphere of natural gas.

Approximately 2,500 pounds of LA142 pellets were produced and shipped in the as-atomized condition to The Dow Metal Products Company production facilities at Madison, Illinois. The fine pellets that were present resulted in extrusion difficulties, which are discussed in a later section of this report, and additional pellets were required to fulfill contractual commitments. These pellets, approximately 1,350 pounds, were produced in the same manner but were screened through a 16 mesh and over an 80 mesh screen prior to shipment (Table I).

Fabrication of Pellets

A. Laboratory Scale

The extrusion of magnesium powder in one form or another has been described by several authors.^{6,7,8} In the present program, most of the LA142 pellets were loaded directly into the 3" diameter container of a 500 ton capacity horizontal extrusion press. The ram was advanced, the pellets compacted, and extrusion begun in essentially a continuous operation. The discard was sheared from the die face at the completion of each push and the extruded section was held in the die opening during compaction of the succeeding push. The effect of exposure at 400F on pellet characteristics and fabricated properties was determined by heating pellets in a covered, stainless steel beaker for various periods of time in an electric, circulating air furnace. These pellets were loaded into the container at temperature. Initial extrusions were 3/8" X 2" in cross-section but the majority of the work was carried out using a 3/4" X 2" round corner die which resulted in an extrusion reduction comparable to that which would be used in production.

The pellet extrusions were cut into appropriate lengths, heated to the desired temperature, and rolled in one heat on an 8" mill with a surface speed of 100 feet per minute.

The rolls were heated by steam or gas flame. Rolling reduction was approximately 20% per pass to final gauges of 1/8" and 1/4" which would correspond to 1" and 2" plate, respectively, rolled on production equipment from a 5 5/8" thick slab. Combinations of broadsiding and longitudinal rolling as well as straight longitudinal rolling were investigated.

Longitudinal and transverse strength properties were determined under all fabrication conditions. Corrosion resistance, as determined by the seven day alternate immersion test in 3% NaCl was evaluated under selected conditions. Appropriate conditions were also selected to evaluate weldability using the tungsten inert-gas method (TIG) with 1/8" material and the metal inert-gas method with 1/4" stock. The weld rod in both cases was AZ92A alloy. All welds were butt welds and mechanical properties were determined in the transverse direction with the bead on and also with the bead machined flush. Corrosion rates were determined on welded samples under the latter condition. A limited number of welds were also x-rayed and rated for soundness using the method reported by Kaiser.⁹

Results on the initial evaluation of LA142 pellets produced in natural gas are shown in Table III. These data indicate that the strength properties of sheet produced from pellets are somewhat better than those of plate produced from ingot.⁴ A brief summary is shown below:

	<u>Stresses in 1000 psi</u>					
	<u>Longitudinal</u>			<u>Transverse</u>		
	<u>% E</u>	<u>TYS</u>	<u>TS</u>	<u>% E</u>	<u>TYS</u>	<u>TS</u>
Laboratory (Pellets)	5-13	16-20	20-23	5-10	16-20	21-23
Production (Ingot)	4-29	13-16	16-21	2-22	13-17	16-22

It is evident that extrusion temperatures of 300 to 400F are satisfactory while an extrusion temperature of 500F results in lower sheet properties. Rolling conditions show that metal temperatures of 250 to 400F have little effect on strength

values with roll temperatures as high as 350F. The most pronounced difference between rolled products produced from LA142 pellets and ingot is in corrosion resistance. The corrosion rate of pellet material (0.5-0.9 MCD) is much lower than that of ingot material (25-32 MCD) used to produce these pellets.

Results obtained on pellets from the last three LA142 melts are found in Table IV. Permanent mold rolling slabs were poured from these melts and processed for comparison with the pellet products. Pellets which had been produced earlier were used to determine the effect of three months storage in a closed container on fabrication characteristics and properties. All the extrusions were produced at a temperature of 300F and a speed of 3 to 5 feet per minute. Material rolled from both pellet and ingot stock was stabilized for six hours at 350F prior to testing. In addition, welded samples were stress relieved for 24 hours at 300F after welding. Values presented for base metal properties are the average of two tests while those for welded properties are generally the average of three tests. Individual test results are recorded on IBM cards in the files of the Laboratory.

Examination of Table IV will show that the properties of LA142 pellet materials are quite insensitive to the rolling conditions investigated except when a metal temperature of 500F is used. The pellet extrusions may be broadsided 25 or 50% prior to longitudinal rolling, rolled only in the longitudinal direction, rolled to either 1/4" or 1/8" gauge, and rolled with metal temperatures from 300-400F with little effect on corrosion resistance or strength properties. A rolling temperature of 500F results in lower mechanical properties and corrosion resistance. The properties of fabricated pellets atomized in argon and natural gas are comparable. Screening pellets (-20+100 mesh) prior to extrusion has little effect of final properties. Storage of pellets for

three months in a closed container has no adverse effect on strength properties or corrosion resistance but these properties are decreased by exposing pellets in air at a temperature of 400F. The strength properties of material fabricated from laboratory ingots are considerably lower than comparable material produced from pellets and the corrosion resistance of pellet material is far superior to that ingot material. Significant results are summarized below for ease of comparison.

Atomizing Atmosphere	Pellet Exposure	Rolling Temperature	Corrosion Rate	<u>Longitudinal</u> <u>Base</u> Properties		
				% E	TYS	TS
Natural gas	none	300F	0.4	17	24	27
" "	"	500F	1.3	16	22	25
Argon	none	300F	0.3	17	24	27
" "	"	500F	2.6	17	22	25
Natural gas	400F (2hr.)	300F	0.5	15	23	26
" "	400F (8hr.)	"	0.4	19	21	24
" "	400F (16hr.)	"	4.6	20	19	23
none (cast ingot)		"	25	14	18	23

The strength properties of welded pellet materials are not significantly affected by processing variables. Corrosion rates of welded samples appear to increase slightly with increasing processing temperature and with increasing time of exposure at 400F. Although one would expect welds of pellet produced material to be quite porous, the radiographic ratings indicate that these welds are generally acceptable.⁹ Weld efficiencies on pellet material are somewhat lower than those of ingot material but actual strength values are comparable. The corrosion resistance of welds in pellet stock (1-4 MCD) is much superior to that of welds produced from ingot stock (13-30 MCD).

The effect of thermal treatments on the corrosion resistance of material produced from pellets was briefly

investigated with the following results.

<u>Processing</u>	<u>Thermal Treatment</u>	<u>Rate</u>	<u>Stabilized</u>	<u>Rate</u>
Extruded and Rolled at 300F	none	0.3 MCD	350F (6 hrs.)	0.3 MCD
" "	600F (1 hr.)*	0.7 MCD	" "	3.4 MCD
" "	700F (1 hr.)*	2.8 MCD	" "	12.4 MCD
" "	800F (1 hr.)*	3.2 MCD	" "	8.3 MCD

Although these data are quite interesting, and confirm the advisability of using minimum fabrication temperatures, further research was considered outside the scope of this contract.

B. Production Scale

Approximately 2,500 pounds of as atomized LA142 pellets were passed through a coarse screen and loaded into stainless steel bombs for pre-heating. The furnace temperature was set at 300F and the bombs were in the furnace for about 12 hours with the pellets under a partial argon atmosphere. Air pressure was used to force the pellets from the bombs, through a flexible hose, and into a 32" diameter container extension of the 13,200 ton extrusion press. Difficulties were encountered with plugging of the flexible hose and this necessitated removal and cleaning of the hose. During one of these cleaning operations, the hose connection was dropped on a metal floor plate and the resulting spark ignited an accumulation of fine LA142 pellets. The fire was quickly extinguished and no one was injured. About half of the heated pellets had been unloaded at this point and the operation was discontinued because of the hazard associated with the quantity of fine pellets in these runs. The extrusion container was purged with argon and the ram advanced through the container extension and into the container without difficulty. Container temperature was 375F and a solid die, heated in a 550F furnace, was used in forming the compact. This die was replaced with a 5 5/8" X 29" rolling slab die and a maximum

* Warm water quenched and refrigerated until tested or stabilized.

pressure of 13,200 tons was used to start the extrusion. Minimum pressure was 8,000 tons and extrusion speed was about one foot per minute. The temperature of the extruded slab varied from 360 to 410F. The first four feet of the extrusion were not usable because of the nose opening and surface tearing. Approximately ten feet of material suitable for rolling were produced. Since all the pellets were not extruded, it was suggested to Frankford Arsenal that the available material be rolled and ballistically tested to determine the advisability of additional extrusion work.

A 5 5/8" X 29" X 28" piece of the extruded slab was heated to 350F and rolled on a 60", two-high, non-reversing mill. The slab was rolled broadside (transverse to the extrusion direction) to 40" at reductions of 1/4" per pass. The slab was then turned and rolled in the extrusion direction to approximately 3" in thickness. The nose opened up (alligatoring) at this gauge so reduction per pass was decreased and the slab was rotated to enter the opposite end. This end also opened up after several passes but, at the final gauge of 2", a solid piece of plate 36" X 28 1/2" was salvaged. This piece was stabilized for 6 hours at 350F and saved for shipment with that to be rolled on the large reversing mill.

To determine conditions which would minimize alligatoring, small pieces (1.9" thick) from the center of the production extruded slab were rolled on the laboratory mill. Rolling temperature (300, 350, and 400F) had no effect on the cracking tendency at reductions comparable to those used in production. It was observed that this alloy "over-rolls" more than the usual magnesium alloys and the "V" caused by the surfaces rolling faster than the center results in a severe notch effect. All the experimental slabs opened at this notch before the final gauge (3/4") was reached (total reduction comparable to production). The nose of a

slab was then pointed to a 90° included angle and rolled at 350F to well beyond the final gauge requirement. This slab was rotated on the last pass and the unpointed end opened immediately. At reductions twice as great as those comparable to production, a pointed slab alligatored as the final gauge was reached. Laboratory extrusions ($3/4"$ X $2"$) were rolled in the extrusion direction at very high reductions and although over-rolling occurred, the production defect could not be duplicated.

Based on the above results, one end of the $5\ 5/8"$ X $29"$ X $96"$ extruded slab was pointed by machining to a 90° included angle and the slab was rolled at 350F on the 84", four-high, reversing mill. The other end of the slab was forged (pointed) in the rolls prior to the return pass. There were no problems with alligatoring at either end under these conditions. Reduction per pass was $1/4"$ to a thickness of $2\ 1/2"$. At this point, a severe cradle occurred and reduction per pass was decreased to produce the 2" finish gauge. Metal temperature was 250F at $2\ 1/2"$ and at final the temperature was 130F. The cradle resulted in poor shape and two attempts were made to remove the waves by stretching at room temperature. The plate broke in the jaw bite during each attempt. However, flatness was improved by the second stretch which withstood a pull of 680 tons before failure occurred. After modification of the stretcher jaws, the plate was heated to 300F, transferred to the stretcher, and held without tension to cause some chilling in the area of the bite. When the metal temperature reached 260F, a force of 200 tons was exerted and permanent set was measured to be $1/4$ to $1/2\%$. This did not produce the desired flatness in the plate and a force of 210 tons was then used which produced a total permanent set of $3/4$ to $1\ 1/4\%$. This resulted in the plate being flat to $0.032"$ in any one foot. Finish temperature of the plate after stretching was 250F. The

plate was then stabilized for 6 hours at 350F and sawed into four pieces 2" X 30" X 36". Properties of the 2" plate produced from LA142 pellets compare well with laboratory results and are shown below:

		<u>Stresses in 1,000 psi</u>							
		<u>Longitudinal</u>				<u>Transverse</u>			
	<u>Rate</u>	<u>% E</u>	<u>TYS</u>	<u>CYS</u>	<u>TS</u>	<u>% E</u>	<u>TYS</u>	<u>CYS</u>	<u>TS</u>
60" Mill Product	0.4 MCD	27	21	23	24	16	22	23	24
84" Mill Product		24	21	21	24	13	24	25	26

Four pieces of LA142 plate (2" X 30" X 36") produced on the larger production mill and one piece (2" X 28 1/2" X 36") produced on the small production mill were shipped to Frankford Arsenal on 1-5-62. Since it was anticipated that ballistic testing of these plates could not be accomplished prior to the contract expiration date (2-22-62), the Detroit Ordnance District requested that the contract be extended to May 22, 1962.

When ballistic results indicated the LA142 plate produced from pellets to be significantly better than any previously tested plate, Frankford Arsenal requested additional testing material under the terms of the contract. An additional time extension was, therefore, requested by the contractor and a completion date of July 22, 1963 was established.

Pellets used for the second production run were screened to remove the majority of the fines prior to shipment. These pellets were not preheated, which previously resulted in transfer problems, but were loaded directly into the 32" diameter container of the 13,200 ton extrusion press. The container and tooling were at 375F and approximately four hours were required for the pellets to reach this temperature. The solid die was reheated to 600F prior to compaction of the pellets. This die was replaced by the rolling slab die and extrusion was conducted without difficulty. The extruded slab was approximately fourteen feet long but it was necessary to scrap slightly more than

a foot because of the nose opening. Cold tears on the corners of the slab were removed by hand salvage and all surfaces were disc sanded prior to rolling.

The extruded slab was heated to 350F and rolled on the 84", four-high, reversing mill at reductions of 1/4" per pass to a thickness of two inches. Very slight alligating occurred as the slab approached final gauge but this was controlled by forging (pointing) the nose end in the mill. Finish temperature was 180F and the plate was flat off the mill. With the exception of a few rolled in slivers the plate was free of rolling defects. The plate was sheared into two pieces (176" and 190" long by 28 1/2" wide) and stabilized for six hours at 350F. Mechanical properties obtained on this plate are shown below:

	<u>Stresses in 1,000 psi</u>			
	<u>% E</u>	<u>TYS</u>	<u>CYS</u>	<u>TS</u>
Longitudinal	29	20	21	22
Transverse	13	22	23	25

These values compare well with those obtained on the previous production material.

The stabilized plates were sawed into nine pieces 2" X 28 1/2" X 36" and shipped to Frankford Arsenal on March 22, 1963.

Materials Balance

Surplus government property from Contract No. DA-20-018-ORD-15379 was transferred to subject Contract as follows:

5,000 pounds of LA142 solid scrap

1,700 pounds of special flux (N.A. #8166)

50 pounds of lithium metal

These materials were used in the production of LA142 pellets which were processed as discussed herein. Distribution of the materials is shown in Table V.

Conclusions:

1. Atomized pellets of LA142 alloy produced in argon and natrual gas atmospheres exhibit comparable surface and fabrication characteristics.

2. The mechanical properties and corrosion resistance of sheet and plate produced from LA142 pellets are insensitive to processing variables at fabrication temperatures up to 400F.

3. Strength properties of sheet and plate produced from pellets are slightly higher than those of material produced from ingot. Weld strengths of pellet and ingot materials are comparable.

4. Corrosion resistance of the pellet product is far superior to that of material produced in the conventional manner.

5. Pellets of LA142 alloy can be processed on production equipment with the resulting plate exhibiting superior ballistic characteristics.

References:

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2. Battelle Memorial Institute, "Evaluation of Magnesium-Lithium Base Alloys for Possible Missile Application", Contract No. DA-33-019-ORD-2593
3. Armour Research Foundation, "Magnesium-Lithium Alloys for Armored Vehicle Application", Contract No. DA-11-022-507-ORD-3262
4. The Dow Chemical Company, "Development of Experimental Magnesium Alloy Components for Armored Personnel Carrier, M113", Contract No. DA-20-018-ORD-15739
5. Busk, R. S. "The Pellet Metallurgy of Magnesium", The Magnesium Association and Magnesium Industrial Council, May 23-27, 1960, London England
6. Busk, R. S. and Leontis, T. E. "The Extrusion of Powdered Magnesium Alloys", Trans. A.I.M.E. 188, 1950, p.297
7. Brown, D. J. "Powder Metallurgy of Magnesium", Iron and Steel Institute Symposium, Dec. 1954, p.100
8. Foerster, G. S. and Johnson, H. A. "Beef Up Magnesium Structures", Product Engineering, May 12, 1958
9. Kaiser Aluminum Corporation, "Welding of Ballistic H-Plates from Experimental Armor Plates", Contract No. DA-04-200-507-ORD-333

TABLE I
PRODUCTION OF LA142 PELLETS

<u>Laboratory Evaluation</u>						
<u>Alloy No.</u>						
	<u>92729</u>	<u>92730</u>	<u>92731</u>	<u>93260</u> *	<u>93261</u> *	<u>93262</u>
Gas Pressure-lbs.	22	15	10	20	20	15
Pounds Produced	52	56	50	30	28	41
Screen Analysis - %						
+20	2.5	7.5	28.0	10.0	11.5	5.0
+60-20	24.5	55.5	58.0	53.0	54.0	37.0
+80-60	18.5	12.0	7.0	16.0	13.5	22.0
-80	54.5	25.0	7.0	21.0	21.0	36.0

*Atomized with argon. All other melts atomized with natural gas.

<u>Production Runs</u>			
<u>#747-#755</u>		<u>#827-#835</u>	
Gas Pressure-lbs.	15-20	Gas Pressure-lbs.	10-15
Pounds Produced	2,578	Pounds Produced	1,378
Screen Analysis - %		Screen Analysis - %*	
+20	6.0	-16+30	20
+60-20	53.0	+60-30	55
+80-60	14.5	+80-60	20
-80	26.5	-80	5

*After screening -16+80 mesh
net pounds produced - 1069

TABLE II
ANALYSES OF LA142 ALLOY PELLETS

Spectroscopic Analyses

<u>Alloy No.</u>	<u>% Al</u>	<u>% Ca</u>	<u>% Cu</u>	<u>% Fe</u>	<u>% Mn</u>	<u>% Ni</u>	<u>% Pb</u>	<u>% Si</u>	<u>% Sn</u>	<u>% Zn</u>
92729	1.3	<.01	.004	<.001	.16	<.001	<.003	<.01	<.01	<.02
92730	1.2	"	.005	"	.16	"	"	"	"	"
92731	1.2	"	.004	"	.17	"	"	"	"	"
93260	1.4	"	.003	"	.15	"	.005	"	"	"
93261	1.4	"	.003	"	.16	"	.006	"	"	"
93262	1.3	"	.003	"	.15	"	.007	"	"	"
93263 Assigned to 92730 after 90 days exposure (closed drum)										

Chemical Analyses

Laboratory Evaluation

<u>Alloy No.</u>	<u>% Li</u>	<u>% Na</u>
92729	14.5	.012
92730	14.9	.008
92731	14.9	.005
93260	15.1	.012
93261	14.9	.012
93262	14.9	.011

Production Runs

<u>Run No.</u>	<u>% Al</u>	<u>% Li</u>	<u>Run No.</u>	<u>% Al</u>	<u>% Li</u>
747	1.4	13.7	827	1.3	13.1
748	1.2	13.5	828	1.3	13.1
749	1.3	13.6	829	1.3	13.0
750	1.4	13.7	830	1.4	13.0
751	1.4	13.5	831	1.4	13.2
752	1.3	13.8	832	1.4	13.9
753	1.6	13.5	833	1.5	13.9
754	1.3	13.5	834	1.4	13.4
755	1.2	13.3	835	1.4	13.4

TABLE III
INITIAL EVALUATION OF LA142 PELLETS
ATOMIZED IN NATURAL GAS

<u>Stresses in 1,000 psi</u>											
<u>Alloy No.</u>	<u>Extrusion</u>	<u>Rolling Temp.-F</u>		<u>Corrosion</u>	<u>Longitudinal Transverse</u>						
	<u>Temp.-F</u>	<u>Metal</u>	<u>Rolls</u>	<u>Rate-MCD</u>	<u>%E</u>	<u>TYS</u>	<u>TS</u>	<u>%E</u>	<u>TYS</u>	<u>TS</u>	
	<u>3/8" X 2" Extrusion</u>										
92729	400			1.3	14	20	24	6	21	24	
92730	350			0.9	6	20	24	8	22	25	
92731	300			0.7	18	21	24	8	22	25	
"	400				17	20	24	6	21	24	
<u>1/16" Sheet Rolled From 3/8" X 2" Extrusion</u>											
92729	400	300	300	0.7	5	18	21	4	18	21	
92730	350	300	300	0.8	11	19	22	6	19	22	
92731	350	300	300	0.8	13	19	23	7	19	23	
92729	300	250	250	0.5	8	19	22	7	20	23	
"	"	300	300		7	19	23	5	19	22	
"	"	400	350		8	20	22	5	20	22	
92730	300	250	250	0.9	10	19	22	6	19	23	
"	"	300	300		10	18	21	6	18	22	
"	"	400	350		11	19	22	6	19	21	
92731	300	250	250	0.8	9	16	20	9	16	21	
"	"	300	300		11	18	21	7	18	22	
"	"	400	350		9	20	22	7	20	21	
<u>1/8" Sheet Rolled From 3/4" X 2" Extrusion</u>											
92731	300	300	300	0.5	13	19	23	10	20	23	
"	350	"	"		13	18	22	11	20	21	
"	500	"	"		13	15	20	9	15	21	

Notes:

1. Pellets not screened
2. Extrusions rolled broadside 60% and then longitudinal to final gauge
3. All material stabilized 6 hours at 350F prior to testing

TABLE IV
EFFECT OF FABRICATION VARIABLES ON THE PROPERTIES OF SHEET
ROLLED FROM LA142 EXTRUDED PELLETS AND INGOT

Alloy Number	Atmosphere	None (Cast slab)	Pellet Exposure	Direction	Final Gauge	Temp. - F Metal	Rolling Conditions				Corrosion Rate In M.C.D.				Stresses In 1,000 PSI				Weld Efficiency In %			
							Base Metal	Weld Rating	Weld Eff.	Corr. Rate	Longitudinal TS	Transverse TS	Weld Eff.	Corr. Rate	Weld Eff.	Corr. Rate	Weld Eff.	Corr. Rate	Weld Eff.	Corr. Rate	Weld Eff.	Corr. Rate
93260	Argon	None	None	25°B	1/4"	300	8 20 23 3 22 24	18	92	18	8 20 23 3 22 24	22 24	92	12	92	12	2 18 22	12	92	12	2 18 22	12
"	"	"	"	"	1/8"	500	15 19 23 7 21 24	17	92	17	15 19 23 7 21 24	21 24	92	20	92	20	3 18 21	15	92	20	3 18 21	15
"	"	"	"	"	1/4"	500	6 19 22 2 20 22	24	87	23	10 18 22 5 19 23	23	87	16	91	16	2 16 20	16	91	16	2 16 20	16
93260	Argon	None	None	25°B	1/4"	300	14 24 27 6 24 26	18	78	18	14 24 27 6 24 26	26	78	3.7	85	3.7	5 18 21	3.7	85	3.7	5 18 21	3.7
"	"	"	"	"	"	500	15 24 27 5 22 24	2.6	92	2.6	15 24 27 5 22 24	24	92	4.5	87	4.5	3 17 22	4.5	87	4.5	3 17 22	4.5
"	"	"	"	50°B	1/8"	300	12 23 25 7 24 25	18	85	18	12 23 25 7 24 25	25	85	1.2	89	1.2	1 21 22	1.2	89	1.2	1 21 22	1.2
"	"	"	"	25°B	1/4"	"	10 22 25 7 24 26	0.3	74	0.3	10 22 25 7 24 26	27	74	2.4	82	2.4	3 17 20	2.4	82	2.4	3 17 20	2.4
"	"	"	"	50°B	1/8"	"	17 24 27 7 24 26	0.3	85	0.3	17 24 27 7 24 26	26	85	1.1	85	1.1	2 19 22	1.1	85	1.1	2 19 22	1.1
"	"	"	"	Long.	1/8"	"	18 24 27 4 26 29	0.3	66	0.3	18 24 27 4 26 29	29	66	2.8	59	2.8	1 17 19	2.8	59	2.8	1 17 19	2.8
93261	None (Cast slab)	"	"	"	1/4"	300	5 18 22 1 20 21	17	95	17	5 18 22 1 20 21	21	95	13	100	13	3 17 20	13	100	13	3 17 20	13
"	"	"	"	"	1/8"	500	9 17 22 2 18 20	18	100	18	9 17 22 2 18 20	20	100	14	100	14	5 16 22	14	100	14	5 16 22	14
"	"	"	"	"	1/4"	"	4 17 21 3 19 21	23	100	23	4 17 21 3 19 21	21	100	14	100	14	3 17 21	14	100	14	3 17 21	14
93261	Argon	None	None	25°B	1/4"	300	8 16 21 3 17 21	17	85	17	8 16 21 3 17 21	21	85	2.2	85	2.2	6 17 23	2.2	85	2.2	6 17 23	2.2
"	"	"	"	50°B	1/8"	300	17 24 27 8 25 27	0.3	83	0.3	17 24 27 8 25 27	27	83	2.6	83	2.6	6 17 24	2.6	83	2.6	6 17 24	2.6
"	"	"	"	Long.	1/4"	"	12 24 28 7 24 28	0.3	68	0.3	12 24 28 7 24 28	28	68	3.0	68	3.0	1 16 17	3.0	68	3.0	1 16 17	3.0
93263	Natural Gas	90 Days	90 Days	25°B	1/4"	300	14 23 25 9 24 26	1.1	74	1.1	14 23 25 9 24 26	26	74	3.4	70	3.4	1 16 17	3.4	70	3.4	1 16 17	3.4
"	"	"	"	50°B	1/8"	"	14 25 27 6 25 26	0.9	65	0.9	14 25 27 6 25 26	26	65	3.5	69	3.5	1 16 17	3.5	69	3.5	1 16 17	3.5
"	"	"	"	Long.	1/4"	"	18 24 27 10 26 29	0.9	65	0.9	18 24 27 10 26 29	29	65	3.5	69	3.5	1 16 17	3.5	69	3.5	1 16 17	3.5

TABLE IV (Continued)
EFFECT OF FABRICATION VARIABLES ON THE PROPERTIES OF SHEET
ROLLED FROM L142 EXTRUDED PELLETS AND INGO

Pellets Extruded At 300F, 3-5'/min., 3/4" x 2" Die										Stresses In 1,000 PSI					Weld Efficiency In %																
Sheet Stabilized At 350F (6 Hrs.), Stress Relieved At 300F (24 Hrs.)										Corrosion Rate In M.C.D.					Welds - A292A Rod																
Alloy Number	Atomizing Atmosphere	Pellet Exposure	Direction	Final Gauge	Temp. Metal	Rolls	P	Corr. Rate	Base Metal			Weld			Bead Off																
									Longitudinal SE TYS	TS	Transverse SE TYS	TS	Weld Rating	Weld Eff.	Corr. Rate	SE	TYS	TS	Weld Eff.												
93262	None (Cast slab)	None	25°B	1/4"	300	180	"	25	14	18	23	9	19	23	100	5	19	23	17	100	6	18	23								
"	"	"	"	1/8"	"	"	"	25	17	17	22	11	19	23																	
"	"	"	"	1/8"	500	"	"	27	13	17	22	7	18	22	95	3	17	21	30	100	4	17	22								
"	"	"	"	1/8"	"	"	"	25	16	16	21	13	17	22	95	7	16	21	31	95	8	16	21								
93262	Natural Gas	None	25°B	1/4"	300	300	"	0.4	17	24	27	12	24	27	C					85	6	17	23				2.6	82	4	18	22
"	"	"	"	"	400	180	"	0.3	15	23	26	10	24	27	D					82	4	17	22				2.7	82	6	17	22
"	"	"	"	"	500	300	"	1.9	15	23	26	5	24	26																	
"	"	"	50°B	1/8"	300	300	"	0.3	14	23	25	11	24	25																	
"	"	"	"	"	400	180	"	14	23	26	10	24	26																		
"	"	"	"	"	500	"	"	12	23	25	7	24	25																		
"	"	"	Long.	1/4"	300	300	"	0.5	17	25	27	7	26	29																	
"	"	"	"	"	400	180	"	0.5	17	24	27	7	26	29	C					76	5	17	22				3.6	76	4	17	22
"	"	"	"	"	500	"	"	1.3	16	22	25	8	22	25																	
93262	Natural Gas Screened-20+100	None	25°B	1/4"	300	180	"	0.4	17	25	28	10	26	29	B					76	6	16	22				2.6	79	6	17	23
"	"	"	Long.	"	"	"	"	0.3	21	24	27	7	26	29	B					79	6	17	23				2.4	79	6	17	23
"	"	400F(2Hr)	25°B	"	"	300	"	0.5	16	23	27	7	24	26	C					85	4	18	22				3.5	85	4	17	22
"	"	"	"	1/8"	"	180	"	0.5	15	23	26	11	25	27	C					78	4	17	21				2.5	81	3	17	22
"	"	"	50°B	"	"	300	"	0.6	14	22	24	14	23	25																	
"	"	"	"	1/8"	"	180	"	0.5	13	23	26	8	24	25																	
"	"	"	Long.	1/4"	"	"	"	0.5	19	25	28	8	24	28	C					79	5	17	22				3.2	79	3	17	22
"	"	400F(8Hr)	25°B	"	"	"	"	0.4	19	21	24	16	21	24	C					92	6	16	22				4.3	92	7	16	22
"	"	"	"	"	500	"	"	17	17	22	25	13	22	24	B					96	6	17	23				3.2	96	6	17	23
"	"	"	50°B	1/8"	"	"	"	0.4	13	22	25	11	22	24	B					87	4	17	21				1.3	87	6	17	21
"	"	"	Long.	1/4"	"	"	"	0.5	21	20	24	11	22	24	C					92	4	17	22				4.0	92	7	17	22
"	"	400F(16Hr)	25°B	1/8"	"	"	"	0.8	20	18	23	11	19	24	B					87	4	16	21				7.7	87	5	17	22
"	"	"	50°B	1/8"	"	"	"	1.5	18	17	21	12	18	22	C					86	3	14	19				2.2	86	7	14	19
"	"	"	Long.	1/4"	"	"	"	4.6	20	19	23	11	20	24	B					92	3	17	22				3.9	92	2	17	19

TABLE V
MATERIALS BALANCE

INITIAL INVENTORY

50 lbs. L1 Metal
5000 lbs. LA142 Solid Scrap
1700 lbs. L1 Flux

LA142 PELLETS PRODUCED

257 lbs. for laboratory evaluation
2578 lbs. for production
2835 lbs. Total

MATERIAL USED

1 lb. L1 Metal
3079 lbs. LA142 Solid Scrap
700 lbs. L1 Flux

DISTRIBUTION OF LA142 PELLETS

2" Plate shipped to Frankford Arsenal (1-5-62)	534 lbs.
Solid Scrap	831 lbs.
Unused Pellets	648 lbs.
Saw Chips & Machining Scrap (Burned)	204 lbs.
Contaminated Pellets & Fines (Burned)	<u>618 lbs.</u>
	2835 lbs. Total

INVENTORY AS OF 5-1-62

49 lbs. L1 Metal
2752 lbs. LA142 Solid Scrap
648 lbs. LA142 Pellets (Questionable quality)
1000 lbs. L1 Flux

LA142 PELLETS PRODUCED (2nd Production Run)

1378 lbs. new pellets
648 lbs. from inventory
2026 lbs. Total

MATERIAL USED

1877 lbs. LA142 solid scrap
300 lbs. L1 Flux

DISTRIBUTION OF LA142 PELLETS

2" Plate shipped to Frankford Arsenal (3-27-63)	920 lbs.
Solid Scrap	577 lbs.
Saw Chips & Machining Scrap (Burned)	10 lbs.
Contaminated Pellets & Fines (Burned)	<u>519 lbs.</u>
	2026 lbs. Total

FINAL INVENTORY

49 lbs. L1 Metal
1452 lbs. LA142 Solid Scrap
700 lbs. L1 Flux